

AMENDMENTS TO THE CLAIMS

1. (Currently amended) A pixel cell for an image sensor, the pixel cell comprising:

a photodiode for generating charge in response to light and for amplifying the generated charge, the photodiode being formed within a substrate and below an upper surface thereof and comprising at least two of a first layer having a first band gap and at least two of a second layer having a second band gap, wherein the first layers are alternated with the second layers, wherein the first layers are not in direct contact with one another and the second layers are not in direct contact with one another, and wherein the at least two first layers and the at least two second layers are configured to promote ionization by a first carrier type and suppress ionization by a second carrier type in the presence of an electric field, wherein the first layers are doped to a first conductivity type, wherein the second layers are doped to a second conductivity type, and wherein the first conductivity type is different from the second conductivity type;

a gate of a transistor adjacent to the photodiode, the transistor for transferring the amplified charge from the photodiode; and

a graded buffer layer beneath a bottom layer of the photodiode.

2. (Previously presented) The pixel cell of claim 1, wherein a difference between the conduction band energies of the first layer and the second layer is greater than a difference between the valence band energies of the first layer and the second layer.

3. (Previously presented) The pixel cell of claim 1, wherein a difference between the valence band energies of the first layer and the second layer is greater than a difference between the conduction band energies of the first layer and the second layer.

4. (Canceled).

5. (Previously presented) The pixel cell of claim 1, wherein the at least two first layers and the at least two second layers are each formed of a material selected from the group consisting of Si, $\text{Si}_x\text{Ge}_{1-x}$, $\text{Si}_x\text{Ge}_{1-x}\text{C}_y$, GaAs, GaAlAs, InP, InGaAs, and InGaAsP.

6. (Previously presented) The pixel cell of claim 1, wherein the first layer is Si and the second layer is SiGe.

7. (Currently amended) ~~The pixel cell of claim 6,~~ A pixel cell for an image sensor, the pixel cell comprising:

a photodiode for generating charge in response to light and for amplifying the generated charge, the photodiode being formed within a substrate and below an upper surface thereof and comprising at least two of a first layer having a first band gap and at least two of a second layer having a second band gap, wherein the first layers are alternated with the second layers, wherein the first layers are not in direct contact with one another and the second layers are not in direct contact with one another, and wherein the at least two first layers and the at least two second layers are configured to promote ionization by a first carrier type and suppress ionization by a second carrier type in the presence of an electric field;

a gate of a transistor adjacent to the photodiode, the transistor for transferring the amplified charge from the photodiode; and

a graded buffer layer beneath a bottom layer of the photodiode,

wherein the first layer is Si and the second layer is SiGe, wherein the layers of Si are doped to a first conductivity type, wherein the layers of SiGe are doped to a second conductivity type, and wherein the first conductivity type is different than the second conductivity type.

8. (Currently amended) The pixel cell of claim 6, wherein the photodiode comprises at least four layers of Si and at least four layers of SiGe, wherein the layers of Si are alternated with the layers of SiGe to form an Si/SiGe structure, wherein at least a first subset of layers comprising two layers of Si and two layers of SiGe is doped to a first conductivity type, wherein at least a second subset of layers comprising two layers of Si and two layers of SiGe is doped to a second conductivity type, and wherein the first conductivity type is different than the second conductivity type.

9. (Previously presented) The pixel cell of claim 1, wherein the first layer is $\text{Si}_x\text{Ge}_{1-x}$ and the second layer is $\text{Si}_y\text{Ge}_{1-y}$.

10. (Previously presented) The pixel cell of claim 1, wherein the first layer is $\text{Si}_x\text{Ge}_{1-x}\text{C}_y$ and the second layer is $\text{Si}_x\text{Ge}_y\text{C}_z$.

11. (Previously presented) The pixel cell of claim 1, wherein at least a portion of the photodiode is at a level below the level of a top surface of the substrate.

12. (Previously presented) The pixel cell of claim 1, wherein the photodiode comprises approximately 10 to approximately 100 layers.

13. (Previously presented) The pixel cell of claim 1, wherein each of the layers have a thickness of approximately 50 Angstroms to approximately 300 Angstroms.

14. (Canceled).

15. (Previously presented) The pixel cell of claim 1, further comprising a reset transistor for resetting the photodiode to a predetermined voltage.

16. (Previously presented) The pixel cell of claim 1, further comprising a floating diffusion region, wherein the transistor is a transfer transistor for transferring charge from the photodiode to the floating diffusion region.

17. (Previously presented) The pixel cell of claim 1, wherein the photodiode is part of a CMOS image sensor.

18. (Previously presented) The pixel cell of claim 1, wherein the photodiode is part of a charge coupled device image sensor.

19. (Previously presented) The pixel cell of claim 1, wherein the substrate is a silicon-on-insulator substrate.

20. (Currently amended) An image sensor comprising:
an array of pixel cells at a surface of a substrate, wherein at least one of the pixel cells comprises a photodiode formed within the substrate and below an upper surface thereof, the photodiode comprising at least two of a first layer comprising a first material and at least two of a second layer comprising a second material, wherein the first layers are not in direct contact with one another and the second layers are not in direct contact with one another, wherein the layers are configured such that a difference between the conduction band energies of the first and second materials and a difference between the valence band energies of the first and second materials promotes ionization by a first carrier type and suppresses ionization by a second carrier type in the presence of an electric field and wherein the first layers are alternated with the second layers, wherein a first subset of layers comprises two first layers and two second layers, wherein a second subset of layers comprises two first

layers and two second layers, wherein first and at least second subsets of the layers are doped to first and second conductivity types, respectively, and wherein the first conductivity type is different than the second conductivity type;

a gate of a transistor adjacent to the photodiode, the transistor for transferring the amplified charge from the photodiode; and

a graded buffer layer beneath a bottom layer of the photodiode.

21. (Previously presented) The image sensor of claim 20, wherein the first and at least second materials are selected from the group consisting of Si, $\text{Si}_x\text{Ge}_{1-x}$, $\text{Si}_x\text{Ge}_{1-x}\text{C}_y$, GaAs, GaAlAs, InP, InGaAs, and InGaAsP.

22. (Previously presented) The image sensor of claim 20, wherein the first material is Si and the second material is SiGe.

23. (Currently amended) ~~The image sensor of claim 22;~~ An image sensor comprising:

an array of pixel cells at a surface of a substrate, wherein at least one of the pixel cells comprises a photodiode formed within the substrate and below an upper surface thereof, the photodiode comprising at least two of a first layer comprising a first material and at least two of a second layer comprising a second material, wherein the first layers are not in direct contact with one another and the second layers are not in direct contact with one another, wherein the layers are configured such that a difference between the conduction band energies of the first and second materials and a difference between the valence band energies of the first and second materials promotes ionization by a first carrier type and suppresses ionization by a second carrier type in the presence of an electric field and wherein the first layers are alternated with the second layers;

a gate of a transistor adjacent to the photodiode, the transistor for transferring the amplified charge from the photodiode; and

a graded buffer layer beneath a bottom layer of the photodiode,
wherein the first material is Si and the second material is SiGe, wherein the
layers of Si are doped to a first conductivity type, ~~and~~ wherein the layers of SiGe are
doped to a second conductivity type, and wherein the first conductivity type is
different than the second conductivity type.

24. (Currently amended) ~~The image sensor of claim 22,~~ An image sensor
comprising:

an array of pixel cells at a surface of a substrate, wherein at least one of the
pixel cells comprises a photodiode formed within the substrate and below an upper
surface thereof, the photodiode comprising at least two of a first layer comprising a
first material and at least two of a second layer comprising a second material,
wherein the first layers are not in direct contact with one another and the second
layers are not in direct contact with one another, wherein the layers are configured
such that a difference between the conduction band energies of the first and second
materials and a difference between the valence band energies of the first and second
materials promotes ionization by a first carrier type and suppresses ionization by a
second carrier type in the presence of an electric field and wherein the first layers are
alternated with the second layers;

a gate of a transistor adjacent to the photodiode, the transistor for transferring
the amplified charge from the photodiode; and

a graded buffer layer beneath a bottom layer of the photodiode,
wherein the first material is Si and the second material is SiGe, wherein the
photodiode comprises at least four layers of Si and at least four layers of SiGe,
wherein the layers of Si are alternated with the layers of SiGe to form a Si/SiGe
structure, wherein at least a first subset comprising two layers of Si and two layers of
SiGe is doped to a first conductivity type, and wherein at least a second subset
comprising two layers of Si and two layers of SiGe is doped to a second conductivity

type, and wherein the first conductivity type is different than the second conductivity type.

25. (Previously presented) The image sensor of claim 20, wherein the first material is $\text{Si}_x\text{Ge}_{1-x}$ and the second material is $\text{Si}_y\text{Ge}_{1-y}$.

26 (Previously presented) The image sensor of claim 20, wherein the first material is $\text{Si}_x\text{Ge}_{1-x}\text{C}_z$ and the second material is $\text{Si}_x\text{Ge}_y\text{C}_z$.

27. (Previously presented) The image sensor of claim 20, wherein the photodiode comprises approximately 10 to approximately 100 layers.

28. (Previously presented) The image sensor of claim 20, further comprising a reset transistor for resetting the photodiode to a predetermined voltage.

29. (Previously presented) The image sensor of claim 20, further comprising a floating diffusion region, wherein the transistor is a transfer transistor for transferring charge from the photodiode to the floating diffusion region.

30. (Previously presented) The image sensor of claim 20, wherein the pixel cell further comprises readout circuitry connected to a floating diffusion region for reading out charge.

31. (Previously presented) The image sensor of claim 20, further comprising circuitry peripheral to the array, the peripheral circuitry being at a surface of the substrate, wherein the substrate is a silicon-on-insulator substrate.

32. (Canceled).

33. (Currently amended) ~~The image sensor of claim 32,~~ An image sensor comprising:

an array of pixel cells, wherein at least one of the pixel cells comprises:

a photodiode formed below an upper surface of a substrate, the photodiode comprising at least two layers of Si alternating with at least two layers of $\text{Si}_x\text{Ge}_{1-x}$, wherein the Si layers are not in direct contact with one another and the $\text{Si}_x\text{Ge}_{1-x}$ layers are not in direct contact with one another, and wherein the layers are configured to promote ionization by a first carrier type and suppress ionization by a second carrier type in the presence of an electric field;

a gate of a transistor adjacent to the photodiode, the transistor for transferring the amplified charge from the photodiode; and

a graded buffer layer formed within the substrate and below the photodiode, wherein x is approximately 0.5, wherein the layers of Si are doped to a first conductivity type, wherein the layers of $\text{Si}_x\text{Ge}_{1-x}$ are doped to a second conductivity type, and wherein the first conductivity type is different than the second conductivity type.

34. (Currently amended) ~~The image sensor of claim 32,~~ An image sensor comprising:

an array of pixel cells, wherein at least one of the pixel cells comprises:

a photodiode formed below an upper surface of a substrate, the photodiode comprising at least two layers of Si alternating with at least two layers of $\text{Si}_x\text{Ge}_{1-x}$, wherein the Si layers are not in direct contact with one another and the $\text{Si}_x\text{Ge}_{1-x}$ layers are not in direct contact with one another, and wherein the layers are configured to promote ionization by a first carrier type and suppress ionization by a second carrier type in the presence of an electric field;

a gate of a transistor adjacent to the photodiode, the transistor for transferring the amplified charge from the photodiode; and

a graded buffer layer formed within the substrate and below the photodiode, wherein x is approximately 0.5, wherein first and at least second subsets of the layers are doped to first conductivity and second conductivity types, respectively, and wherein the first conductivity type is different than the second conductivity type.

35-56. (Canceled).